AMENDMENTS TO THE SPECIFICATION

Please amend the specification as follows:

Please amend the first paragraph on page 17 as follows:

Preferably, the optical member according to the present invention further comprises a silica-based optical waveguide made of silica-based host glass. This silica-based optical waveguide includes an optical waveguide region doped with Er element. This improves the pumping efficiency or noise figure. The noise figure is improved if the silica-based optical waveguide is disposed on the upstream side of the Bi type optical waveguide as seen in a traveling direction of multiplexed signal light. The pumping efficiency is improved if the silica-based optical waveguide is disposed on the downstream side of the Bi type optical waveguide as seen in the traveling direction of multiplexed signal light. Preferably, the silica-based optical waveguide is codoped with P element and at least one of trivalent ions such as Al^{3+}, La^{3+} and so on ~~Al and La elements~~. This expands the gain band in L band.

Please amend the fourth paragraph on page 19 as follows:

Fig. 14 is a graph showing a relationship between signal light wavelength and standardized DGT ~~GDT~~;

Please amend first paragraph on page 20 as follows:

Figs. 20A and 20B are graphs showing relationships between signal light wavelength and gain and relationships between signal light wavelength and noise figure in the optical communications systems shown in Figs. 19A and 19B ~~Fig. 19~~.

Please amend the last paragraph on page 21 and continuing onto page 22 as follows:

The optical transmitting station 10 comprises light source units 11_{C1} to 11_{C4}, light source units 11_{L1} to 11_{L4}, an optical multiplexer 12_C, an optical multiplexer 12_L, an optical amplification apparatus 13_C, an optical amplification apparatus 13_L, and an optical multiplexer 14. The light source units 11_{C1} to 11_{C4} output signal light in which a plurality of channels of wavelengths different from each other included in C band are multiplexed. The optical multiplexer 12_C inputs therein the respective signal channels of light in C band outputted from the light source units 11_{C1} to 11_{C4}, and combines them. The optical amplification apparatus 13_C inputs therein the multiplexed signal light of C band combined by the optical multiplexer 12_C, and collectively amplifies this signal light. The light source units 11_{L1} to 11_{L4} output signal light in which a plurality of channels of wavelengths different from each other included in L band are multiplexed. The optical multiplexer 12_L inputs therein the respective signal channels of light in L band outputted from the light source units 11_{L1} to 11_{L4}, and combines them. The optical amplification apparatus 13_L inputs therein the multiplexed signal light of L band combined by the optical multiplexer 12_L, and collectively amplifies this signal light. The optical multiplexer 14 inputs therein the multiplexed signal light of C band outputted from the optical amplification apparatus 13_C and the multiplexed signal light of L band ~~C band~~ outputted from the optical amplification apparatus 13_L, and combines them. The multiplexed signal light combined by the optical multiplexer 14 is sent to the optical fiber transmission line 40.

Please amend the first paragraph on page 22 as follows:

The optical repeating station 20 comprises an optical demultiplexer 21, an optical multiplexer 22 ~~23~~, an optical amplification apparatus 23_C, and an optical amplification apparatus

23_L. The optical demultiplexer 21 inputs therein the multiplexed signal light having arrived by way of the optical fiber transmission line 40, and divides it into C and L bands. The multiplexed signal light divided into C band is guided to the optical amplification apparatus 23_C, whereas the multiplexed signal light divided into L band is outputted to the optical amplification apparatus 23_L. The optical amplification apparatus 23_C inputs therein the multiplexed signal light of C band outputted from the optical demultiplexer 21, and collectively amplifies it. The optical amplification apparatus 23_L inputs therein the multiplexed signal light of L band outputted from the optical demultiplexer 21, and collectively amplifies it. The optical multiplexer 22 inputs therein the multiplexed signal light of C band outputted from the optical amplification apparatus 23_C and the multiplexed signal light of L band ~~C band~~ outputted from the optical amplification apparatus 23_L, and combines them. Thus combined signal light is sent to the optical fiber transmission line 50.

Please amend the second paragraph on page 35 as follows:

The silica-based EDF 233 is an optical fiber made of silica-based host glass having an optical waveguide region doped with Er element. Within the optical waveguide region of the silica-based EDF 233, a population inversion occurs when pumping light outputted from the pumping light source 255 is supplied, whereby the multiplexed signal light is collectively amplified. Preferably, as shown in Fig. 5, the silica-based EDF 233 is disposed on the downstream side of the Bi type EDF 233 as seen in the traveling direction of multiplexed signal light, whereby an excellent pumping efficiency is obtained. It will also be preferred if the silica-based EDF 233 is disposed on the upstream side of the Bi type EDF 232, whereby an excellent noise figure is obtained. Preferably, the silica-based EDF 232 ~~233~~ is codoped with P element

and at least one of <u>trivalent ions such as Al^{3+}, La^{3+}, and so on</u> ~~Al and La elements~~.

Please amend the second paragraph on page 41 as follows:

Figs. 7A and 7B also show gain spectra of a Bi type EDF. Here, population inversions were adjusted such that two maximum gain values coincide with each other at each of 0°C, 25°C, and <u>65°C</u> ~~65~~ within an operating temperature range required for optical communications systems of ground main line type in general. Fig. 7B is a graph enlarging the ordinate of Fig. 7A. The ordinate of Fig. 7B indicates the gain non-uniformity with reference to the minimum gain value at each temperature. In Figs. 7A and 7B, curves G510a and G510b show gain spectra at the temperature of 0°C, curves G520a and G520b show gain spectra at the temperature of 25°C, and curves G530a and G530b show gain spectra at the temperature of 65°C.

Please amend the last paragraph on page 49 as follow:

As explained in connection with the above-mentioned expression (3), even when the gain spectrum is flat in a Bi type EDF because of the Er transition therein, the relative gain non-uniformity in the net gain of the Bi type EDF deteriorates if background loss is large. Fig. 8 is a graph for explaining a relationship between relative gain non-uniformity and background loss in the net gain of a Bi type EDF. As illustrated in this graph, the net gain spectrum G620 of the Bi type EDF is obtained by subtracting the loss ΔE composed of background loss and fusion loss from the gain spectrum G610 caused by the Er transition. Though the difference ΔG between the maximum gain value and minimum gain value does not change, the minimum gain value G_b in the net gain spectrum of the Bi type EDF is lower than the minimum gain value <u>G_a</u> ~~G_b~~ of the gain spectrum because of the Er transition. Therefore, the relative gain non-uniformity in the net gain of the Bi type EDF deteriorates as the background loss is greater. The Bi type EDFs whose gain

spectra are shown in Figs. 6, 7A, and 7B exhibit a particularly small background loss, thereby yielding a small relative gain non-uniformity even as a net gain. Typically, however, Bi type EDFs exhibit a background loss of about 2 dB/m.

Please amend the second paragraph on page 50 as follows:

For simplification, operations at room temperature will be explained in the following. The permissible value of background loss α_B (dB/m) of the Bi type EDF and the absorption peak α (dB/m) inherent in Er satisfy the following relationship (7):

$$(0.12 \times 0.042 \times \alpha)/(0.042 \times \alpha - \alpha_B)$$

$\leq$ the relative gain non-uniformity of net gain

(7)

where the constant value 0.12 is the relative gain non-uniformity neglecting the background loss actually measured from the gain spectrum of population inversion 3 shown in Fig. 6, and the constant value 0.042 is the ratio of the gain G_x, which is obtained when a typical operating temperature 40°C in a ground system is put into the above-mentioned expression (2) as the temperature T, to the absorption peak. As mentioned above, level diagram designing may fail to be on a par with a silica-based EDF for C band if the target value of relative gain non-uniformity exceeds 19%, and advantages over P/Al-codoped silica-based EDFs may be lost if the target value exceeds 25%. Therefore, the target value of relative gain non-uniformity is preferably 25% or less ~~or more~~, more preferably 19% or less ~~or more~~.

Please amend the last paragraph on page 54, continuing onto page 55 as follows:

Also, as mentioned above, the P/Al-codoped silica-based EDF has a large relative gain non-uniformity, which makes it practically problematic to use the P/Al-codoped silica-based

EDF alone. Hence, it is preferred to use the P/Al-codoped silica-based EDF and Bi type EDF in combination. Preferably, a silica-based EDF is doped with at least one of Al and La elements in addition to P element. When doped with none of trivalent ions ~~Al and La elements~~, the silica-based EDF remarkably deteriorates its noise figure as shown in Fig. 10 even in the case of forward pumping at 100 mW. Without being restricted to Al and La elements, elements adapted to become trivalent ions seem to function similarly.

Please amend the second paragraph on page 64 as follows:

Fig. 15 is a diagram showing the configuration of a sixth embodiment of the optical amplification apparatus according to the present invention. The optical amplification apparatus 600 shown in this diagram comprises, successively from its input end 601 to output end 602, an optical coupler 611, an optical isolator 621, an optical coupler 613, a Bi type EDF 630, an optical isolator 623, an optical coupler 614, the Bi type EDF 630, an optical coupler 615, an optical isolator 622, and an optical coupler 612. The optical amplification apparatus 600 also comprises a light-receiving device 651 (PD) connected to the optical coupler 611, an optical performance monitor 660 (OPM) connected to the optical coupler 612, a pumping light source 653 (LD) to the optical coupler 613, a pumping light source 654 connected to the optical coupler 614, a pumping light source 655 connected to the optical coupler 615, a temperature adjusting device 662 (Peltier device) disposed in contact with or in the vicinity of the Bi type EDF 630 ~~430~~, and a control unit 690 for regulating operations of the optical amplification apparatus 600 as a whole. The control unit 690 comprises a temperature control circuit 691 for feedforward-controlling the temperature adjusting device 662, and a memory 692 for storing actually measured data beforehand for enabling faster feedback control.

Please amend the second paragraph on page 65 as follows:

In an optical communications system, the temperature of an Er-doped Bi type EDF may fluctuate because of changes in temperature within a repeating station, whereby the phenomenon shown in Fig. 7A ~~Fig. 5(a)~~ may cause a gain tilt. In such a case, the temperature of Er doped Bi type EDF may be stabilized by combining a thermistor and a Peltier device as in the third embodiment shown in Fig. 11, for example. Alternatively, as in the optical amplification apparatus according to a seventh embodiment shown in Fig. 17, an optical device having a variable transmission spectrum may be utilized. An example of such optical device having a variable transmission spectrum is a variable attenuator.

Please amend the last paragraph on page 69 and continuing onto page 70 as follows:

As mentioned above, the noise figure of a Bi type EDF for expanded L band does not always reach its quantum limit. It is therefore preferable to improve the noise figure more by combining a Raman amplifier with each of the optical amplification apparatus according to the embodiments. For verifying this fact, optical communications systems having respective configurations shown in Figs. 19A and 19B were prepared. The optical communications system shown in Fig. 19A is constituted by a transmission line fiber 900 (SMF: Single-Mode Fiber) having a length of 80 km, an optical amplification apparatus (Bi-EDFA) 910 ~~920~~ including a Bi type EDF according to the present invention, and a gain equalizer 920. As with the optical communications system of Fig. 19A, the optical communications system shown in Fig. 19B (a second embodiment of the optical communications system according to the present invention) comprises an SMF 900 having a length of 80 km, a Bi-EDFA 910, and a gain equalizer 920, and

further comprises a pumping light supply system 940 for supplying a plurality of channels of pumping light to the SMF 900 by way of an optical coupler 930, thereby constituting a distribution Raman amplifier on the upstream side of the Bi-EDFA. In the optical communications system of Fig. 19B, the pumping light supply system 940 comprises a light source 942a for outputting light having a wavelength of 1468 nm and an output of 166 mW as a pumping channel, a light source 942b for outputting light having a wavelength of 1472 nm and an output of 269 mW as a pumping channel, a light source 942c for outputting light having a wavelength of 1520 nm and an output of 75 mW as a pumping channel, a light source 942d for outputting light having a wavelength of 1524 nm and an output of 210 mW as a pumping channel, and a multiplexer 941 for combining the respective pumping channels outputted from the light sources 942a to 942d.

Please amend the second paragraph on page 71 as follows:

In Fig. 20A, curves G1810a, G1821a, G1822a, and G1823a indicate the gain spectrum of the Bi-EDFA in the optical communications system shown in Fig. 19A, the ON/OFF gain of the distribution type Raman amplifier in the optical communications system shown in Fig. 19B, the gain spectrum of the Bi-EDFA alone in the optical communications system shown in Fig. 19B, and the total gain of the optical communications system shown in Fig. 19B, respectively. In Fig. 20B, curves G1810b, G1821b, G1822b, and G1823b indicate the gain spectrum of the Bi-EDFA in the optical communications system shown in <u>Fig. 19B</u> ~~Fig. 19A~~, the ON/OFF gain of the distribution type Raman amplifier in the optical communications system shown in Fig. 19B, the gain spectrum of the Bi-EDFA alone in the optical communications system shown in Fig. 19B, and the total gain of the optical communications system shown in Fig. 19B, respectively.